CLAIMS

What is claimed is:

1. A method for forming a dense region of a dielectric layer, comprising:

providing a substrate;

forming a dielectric layer on said substrate;

forming a photoresist layer and defining a predetermined region for ion implantation on said dielectric layer;

forming a dense region in said dielectric layer by using a retrograde implantation process and said photoresist layer as a ion implanted mask; and

removing said photoresist layer.

2. The method according to claim 1, wherein said dielectric layer comprises a low-K dielectric material.

3. The method according to claim 1, wherein the method for forming said dielectric layer comprises a deposited process.

4. The method according to claim 1, wherein said retrograde implantation process comprises a phosphorous ion.

5. The method according to claim 1, wherein said retrograde implantation process comprises a boron ion.

6. The method according to claim 1, wherein said retrograde implantation process comprises a first energy about between 20 and 100 KeV.

7. The method according to claim 1, wherein said retrograde implantation process comprises a second energy about between 350 and 700 KeV.

8. The method according to claim 1, wherein said retrograde implantation process comprises a third energy about between 1 and 3 MeV.

9. A method for forming a dense region of a dielectric layer, comprising:

providing a substrate;

forming a dielectric layer on said substrate;

forming a photoresist layer and defining a predetermined region for ion implantation on said dielectric layer;

performing a first ion implantation process by said photoresist layer as a ion implanted mask to form an ion implantation region in said dielectric layer;

implanting said ion implantation region in said dielectric layer by a second ion implantation process and said photoresist layer as said ion implanted mask;

implanting said ion implantation region in said dielectric layer by a third ion implantation process and said photoresist layer as said ion implanted mask to form a dense region in said dielectric layer; and

removing said photoresist layer.

10. The method according to claim 1, wherein said first ion implantation process comprises a first ion having dosage about 10^{12} to 10^{15}.

11. The method according to claim 10, wherein said first ion comprises a phosphorous ion.

12. The method according to claim 10, wherein said first ion comprises a boron ion.

13. The method according to claim 9, wherein said first ion implantation process comprises a first energy about between 20 and 100 KeV.

14. The method according to claim 9, wherein said second ion implantation process comprises a second ion having dosage about 10^{12} to 10^{15}.

15. The method according to claim 14, wherein said second ion comprises a phosphorous ion.

16. The method according to claim 9, wherein said second ion implantation process comprises a second energy about between 350 and 700 KeV.

17. The method according to claim 9, wherein said third ion implantation process comprises a third ion having dosage about 10^{12} to 10^{14}.

18. The method according to claim 17, wherein said third ion comprises a phosphorous ion.

19. The method according to claim 9, wherein said third ion implantation process comprises a third energy about between 1 and 3 MeV.

20. A method for patterning a dual damascene, comprising:

providing a substrate;

forming a dielectric layer on said substrate;

forming a first photoresist layer and defining a predetermined region for ion implantation on said dielectric layer;

forming a dense region in said dielectric layer by using a retrograde implantation process and said first photoresist layer as a ion implanted mask;

removing said first photoresist layer;

forming a hard mask layer on said dielectric layer;

forming and defining a second photoresist layer on said hard mask layer to form a predetermined etched region;

etching said predetermined etched region by said second photoresist layer as a etched mask to etch through said hard mask layer and said dielectric layer until a partial surface of said substrate is exposed; and

removing said second photoresist layer to form a pattern of said dual damascene.

21. The method according to claim 20, wherein said dielectric layer comprises a low-K dielectric material.

22. The method according to claim 20, wherein the method for forming said dielectric layer comprises a deposited process.

23. The method according to claim 20, wherein the method of said retrograde implantation process comprises:

implanting said predetermined region of said dielectric layer by a first ion implantation process with a first energy about between 20 and 100 KeV to form an ion implantation region in said dielectric layer;

implanting said ion implantation region in said dielectric layer by a second ion implantation process with a second energy about between 350 and 700 KeV; and

implanting said ion implantation region in said dielectric layer by a third ion implantation process with a third energy about between 1 and 3 MeV to form said dense region in said dielectric layer.

24. The method according to claim 23, wherein said first ion implantation process comprises a first ion having dosage about 10^{12} to 10^{15}.

25. The method according to claim 24, wherein said first ion comprises a boron ion.

26. The method according to claim 24, wherein said first ion comprises a phosphorous ion.

27. The method according to claim 23, wherein said second ion implantation process comprises a second ion having dosage about 10^{12} to 10^{15}.

28. The method according to claim 27, wherein said second ion comprises a phosphorous ion.

29. The method according to claim 23, wherein said third ion implantation process comprises a third ion having dosage about 10^{12} to 10^{14}.

30. The method according to claim 29, wherein said third ion comprises a phosphorous ion.

31. The method according to claim 20, wherein the etched selectivity between said dense region and said dielectric layer is about 2.

32. The method according to claim 20, wherein said pattern comprises a trench.

33. The method according to claim 32, wherein said trench is located in said dense region.

34. The method according to claim 20, wherein said pattern comprises a via hole.

35. A method for forming a pattern of a dual damascene, comprising:

providing a substrate;

forming a dielectric layer on said substrate;

forming a first photoresist layer and defining a first predetermined region and a second predetermined region for ion implantation on said dielectric layer;

performing a first ion implantation process with a first energy about between 20 and 100 KeV by a first ion having dosage about 10^{12} to 10^{15} and said first photoresist layer as a mask to implant into said first predetermined region and said second predetermined region of said dielectric layer;

performing a second ion implantation process with a second energy about between 350 and 700 KeV by a second ion having dosage about 10^{12} to 10^{15} and said first photoresist layer as said mask to implant into said first predetermined region and said second predetermined region of said dielectric layer;

performing a third ion implantation process with a third energy about between 1 and 3 MeV by a third ion having dosage about 10^{12} to 10^{14} and said first photoresist layer as said mask to implant into said first predetermined region and said second predetermined region of said dielectric layer, so as to form a first dense region and a second dense region in said dielectric layer;

removing said first photoresist layer;

forming a hard mask layer on said dielectric layer;

forming and defining a second photoresist layer on said hard mask layer to form a predetermined etched region;

etching said predetermined etched region by said second photoresist layer as a etched mask to etch through said hard mask layer and said dielectric layer until a partial surface of said substrate is exposed; and

removing said second photoresist layer to form said pattern of said dual damascene.

36. The method according to claim 35, wherein said dielectric layer comprises a low-K dielectric material.

37. The method according to claim 35, wherein said first ion comprises a phosphorous ion.

38. The method according to claim 35, wherein said first ion comprises a boron ion.

39. The method according to claim 35, wherein said second ion comprises a phosphorous ion.

40. The method according to claim 35, wherein said third ion comprises a phosphorous ion.

41. The method according to claim 35, wherein the etched selectivity between said dense region and said dielectric layer is about 2.

42. The method according to claim 35, wherein said predetermined etched region comprises said first dense region.

43. The method according to claim 35, wherein said predetermined etched region comprises said second dense region.

44. The method according to claim 35, wherein said pattern comprises a trench.

45. The method according to claim 44, wherein the location of said trench comprises said first dense region.

46. The method according to claim 44, wherein the location of said trench comprises said second dense region.

47. The method according to claim 35, wherein said pattern comprises a via hole.

48. The method according to claim 47, wherein the location of said via hole is between said first dense region and said second dense region.

49. A method for forming a pattern in a dual damascene process, comprising:

providing a substrate;

forming a dielectric layer on said substrate;

forming and defining a first photoresist layer on said dielectric layer;

performing a ion implantation process by said first photoresist layer as a mask to form a dense region in said dielectric layer;

removing said first photoresist layer;

forming and defining a second photoresist layer on said dielectric layer to form a predetermined etched region having said dense region and a part of said dielectric layer;

etching said predetermined etched region by said second photoresist layer as a etched mask, so as to form a trench while said dense region in said predetermined etched region is removed, and form a via hole while said part of said dielectric layer in said predetermined etched region is removed; and

removing said second photoresist layer to form said pattern in said dual damascene process.

50. The method according to claim 49, wherein said ion implantation process comprises a retrograde implantation.